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Influences on the establishment of county wildfire risk mitigation: the case of California's Fire Safe Councils

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INFLUENCES ON THE ESTABLISHMENT OF COUNTY WILDFIRE RISK MITIGATION PROGRAMS: THE CASE OF CALIFORNIA'S FIRE SAFE COUNCILS

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This thesis is dedicated to the memory of Hubert Selby, Jr. Because he knew.

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ABSTRACT

In response to increased annual wildfire destruction and insufficient wildfire mitigation approaches from the federal government, the state of California adopted Public Resources Code Sections 4290 and 4291 in the year 1991. These laws force the removal of fire-causing agents from public and private areas, and establish what is known as defensible space. Defensible space is defined in Section 4291 as the area within the perimeter of a parcel, development, neighborhood, or community where basic wildland fire protection practices and measures are implemented, providing the key point of defense from an approaching wildfire or escaping structure fire.

One method to successfully establish these areas of defensible space is by educating the public about the dangers, causes, and fuel sources of wildfires. County-level public outreach programs known as Fire Safe Councils encourage cooperation within the public sector in regards to state wildfire legislation by publishing fire information and risk-related maps and by conducting prescribed burns which alleviate dead, fire-fueling debris in forests. Local Council chapters are composed of over sixty public and private organizations in and beyond California.

Forty-eight of California's fifty-eight counties have at least one Fire Safe Council. Ten have none. In an attempt to gain insight into what accounts for variation, a total of twelve independent variables concerning socioeconomics and wildfire hazard rating (risk) were constructed to represent each county. Data was collected from various sources and inputted into the statistical modeling program, SPSS, for testing.

Out of the five categories of independent variables; population, economic, education, civic participation, and hazard rating, only variables within the population and

economic categories were determined to have any significant associations with decisions to establish Fire Safe Councils. The results of this study thereby set the stage for changes to be made in current wildfire mitigation, namely, a reevaluation of hazard models and Sections 4290 and 4291.

CHAPTER 1

INTRODUCTION

Problem Statement

The year 2002 marked the next to worst year of fire destruction in the United States over the past five decades. Over seven million acres of forest and low-lying chaparral were burned (www.nfpa.org/NFPAJournal/Covers/Edge/Edge.asp.), predominantly in dry areas of the West. In June, on the Fort Apache Indian Reservation in Arizona, the Rodeo and Chedeski fires united to produce the Southwest's worst fire to that time. This fire burned 468,000 acres, evacuating 32,000 people (www.nfpa.org/JournalArchive/Archives). Later that same year, the Hayman Fire in Colorado, one of the largest in the state's history, grew from 100 to 20,000 acres in a single day. In August, the Bryant Fire swept through California, ravaging over $2.5 million worth of private property and natural resources located in regions dense with brush and pine (www.monolithic.com/gallery/homes/braswell_fire/monolithic.com).

Catastrophic fires continued well into 2003, and in October of that year, California saw some of the worst environmental destruction in the history of the state. News reports routinely included news of fires killing fifteen to twenty people in the course of a single day, forcing upwards of 50,000 people from their homes, darkening over 200,000 acres with soot and ash, causing billions of dollars worth of damages, and pushing insurance claims into the hundreds of billions of dollars (http://twm.co.nz/Calfires.html#LA%20Fires). Mudslides, flooding, and large blazes joining together into a single force claimed the attention of tens of thousands of firefighter personnel per day, as well as emergency and rescue aircraft from several states at a time.

These are but a few instances of a large, ongoing wildfire problem in the United States which spans several disciplines, including: politics, public risk perception, environmental

policy, and property rights. Once a completely natural occurrence, responsible for death and regeneration within ecosystems, wildfires have turned disastrous in the face of human development and settlement. Particularly hazardous areas of growth are discussed in the following section.

Surface Fires

As communities grow in and around fire-prone areas, the threat of life loss and property loss increases. These high-risk areas of development are widely known as the wildland/urban interface, the focus of much current wildfire mitigation and policy. When communities build, impermeable surfaces such as asphalt, concrete, and cement increase in area. In many areas of the West, land surfaces are flat, so drainage to large coulee systems must be rapid so that towns and cities do not flood. The coulees effectively take what little rainfall the arid regions of the West receive and transplant it directly to the ocean. The ground becomes deprived of moisture, and the fire-starting capacity of the region increases.

Although America's wildfires have been amplified by a multitude of both human and non-human factors, they are nothing new to man. Wildfires have been shaping the geography, wildlife, watersheds, soil health, and overall environmental well-being of the North American continent since before the arrival of the first inhabitants. These pre-settlement fires still occur naturally, and they are referred to as surface fires.

Surface fires are those which burn undergrowth along the forest floor, claiming shrubbery before dangerous amounts are allowed to accumulate. Lightning often serves as the impetus to these natural incidents, but "prescribed burns" also take place in which forest underbrush is set afire manually. This is a relatively new practice in the United States, not adopted until the early 20th century. Prior to this, all wildfires were extinguished to the extent possible, a form of

universal prevention policy. This “no fire” policy led to irreversible environmental damage in the form of habitat degradation.

For over a century, saplings were allowed to concentrate in small areas devoid of surface fires, depriving older trees of nourishment. These areas grew overcrowded with dead limbs, dry needles, and other organic material, leading to a hotbed of volatile wildfire fuel. Unfortunately, our shortsightedness has led to the current massive accumulation of underbrush and leaf litter in our national forests. When abundant fuel sources are combined with human carelessness (unattended campfires) and environmental variations (weather patterns), irrepressible fires are often produced.

Surface fires speed up physical and chemical processes in the forest, keeping the environment healthy and “new.” Nutrients in dead undergrowth, limbs, and litter are liberated in fires. When fires are not allowed to burn, decomposition and restorative rates are slow. Some conifers cannot undergo the process of germination at all, much less a speedy process, unless their cones receive excessive amounts of heat. An alternate way in which surface fires keep the environment healthy is by killing many of the disease-carrying insects and pathogens found in parts of the forest.

Succession Relationships

In addition to increasing the frequency and intensity of large fires, the delicate balance of succession relationships between r-strategist species and k-strategist species have been disrupted by the “no fires” policy. R-strategist species use what are known as r-patterns of survival. These species move into an ecosystem quickly, using rapid reproduction for survival in the natural world (Purves, Orians, Heller, and Sadava, p. 1165). The rapid reproduction rates allow for a high rate of mobility through the ecosystem, as well as the ability to cover large areas and get

heavy doses of sunlight. Through these mechanisms, r-strategist species extract resources from the environment which they convert into energy. Common r-strategists are weeds, insects, and rodents, and they are found in prairies as well as forests.

K-strategists rely on efficiency in the utilization of natural resources for survival rather than rapid reproduction. They need much more time to develop, typically staying in one place and using physical features such as large leaf surface area and complex root structure to gain a stranglehold on the sunlight and water available in their area. Common k-use organisms are tall trees found in several types of forest.

The principle of succession, a gradual change from r-strategist to k-strategist, can be stated thus: if a person tills a patch of land and leaves it unattended for an extended period of time, there will be gradual changes in the ecosystem through time. First, there will be grasses and weeds, then small plants and flowers, then small trees and vines, then larger trees. Certain insects and animals would be present with the plants through each phase of development. A tilled patch of land usually results in a k-strategist dominant old growth forest, unless other factors come into play. Surface wildfires are one type of factor that sets the environmental stage for r-strategist colonization. The fires create and retain space in the canopy, allowing plenty of much-needed sunlight to the forest floor where it can be utilized by r-strategists.

Although extreme wildfires threaten the survival of a number of species in the American West, such as red squirrels and spotted owls (http://forests.org), surface fires play a major role in species preservation, both plant and animal. Natural surface fires thus appear to be a product of evolution, a method in which Earth maintains balance between r-strategists and k-strategists. Succession relationships are the product of millions of years of evolution and natural selection, thus represent an efficient manner of recycling energy through the environment given the

conditions of Earth at a particular time. The “no fire” policy severely disturbed this natural balance, setting the stage for wildfire disasters.

Federal Wildfire Policy

Since it is apparent that wildfire mitigation in America has been mismanaged for a long time due to ignorance in land management practices and policymaking, various attempts are being made by decision-makers at local, state, and national levels to mitigate the occurrence of these disasters. This section focuses on wildfire policy at the federal level. Subsequent sections address the state and local levels, the primary areas of concern in respect to this research.

In August 2002, the United States developed its National Fire Plan, a comprehensive wildfire mitigation and prevention policy. The USDA Forest Service and the U.S. Department of the Interior have the primary roles in seeing that the fundamental objectives of the Plan are met each year. These departments work through their agencies to achieve these conditions, which must be met in accordance with the Plan (http://www.fireplan.gov/overview/whatis.html):

1) Assuring that necessary firefighting resources and personnel are available to respond to wildland fires which threaten lives and property.

2) Conducting emergency stabilization and rehabilitation activities on landscapes and communities affected by wildland fire.

3) Reducing hazardous fuels (dry brush and trees that have accumulated and increase the likelihood of unusually large fires) in the country’s forests and rangelands.

4) Providing assistance to communities that have been or may be threatened by wildland fire.

5) Committing to the Wildland Fire Leadership Council, an interagency team created to establish and maintain high standards for wildland fire management on public lands.

The National Fire Plan offers protection through program grants. Federal funds are used to conduct prescribed burns, provide forest restoration, provide flood protection, construct structures referred to as "fuelbreaks" that defend private property from the prescribed burns and provide other safety precautions meant to accommodate the five National Fire Plan conditions. Some of these precautions extend to the digital world, such as funding for remote sensing research, cutting-edge smoke detection, and supersensitive radar. After prolonged study, it becomes clear that there must be a balance between proactive and reactive wildfire policy, between pre-fire protection and post-fire damage control. The increased severity and frequency of wildfires suggests that this balance may be as delicate as the one between succession relationships in the world's ecosystems.

Another technique of federal, pre-fire mitigation is public outreach. People who own and are in charge of both private and public property must understand how fires start, spread, and worsen. They must understand the fundamentals of overpopulation and the danger of living close to the wildland urban/interface.

America's wildfire public outreach programs do not get enough attention from the federal government. Government spending on fuel reduction is a major step in terms of reducing fire hazards, but a close examination of current fuel reduction policies is needed. The current Healthy Forest Initiative is a landmark demonstration of how the federal government is addressing fire fuel reduction.

President Bush submitted legislation to establish the Healthy Forest Initiative to Congress in 2002. Its written purpose is to suppress fires and prevent them when possible, to promote community assistance to areas affected by fires, to restore fire-adapted ecosystems, and to reduce fuels. Once enacted, the Initiative took the forest fire problems of the Western U.S. and spread

the cost to all tax-paying Americans. To many environmentalists, Bush's plan for fire prevention is indicative of federal politics protecting the logging and timber industry. The Healthy Forest Initiative is actually a long-term cooperative effort with the USDA Forest Service, Department of the Interior, and the National Association of State Foresters. It complies with the 1994 Northwest Forest Plan written during the Clinton administration, which was created with the intent of expanding and intensifying the logging of old growth national forests. Thus, the Healthy Forest Initiative relieves pressure on the timber industry coming from environmentalists. Environmentalists have historically taken their demands to ban logging to the courts and have often seen them upheld due to the National Environmental Policy Act and the Endangered Species Act.

Many environmental groups believe that logging in national forests will increase greatly over the next few years due to the Healthy Forest Initiative, severely undermining the policies of NEPA. Trees of interest to the timber companies are not cited most often in literature as constituting the major threat to fire safety. The Firewise Program, sponsored by the NFPA and a consortium of wildland fire agencies in California, Colorado, and other Western states, explains to communities within the wildland/urban interface that shrubs, bushes, and dead limbs around homes are the major threat to public wildfire safety (www.firewise.org).

Many state legislators find problems with federal wildfire policy. They are skeptical of the Healthy Forest Initiative since increased logging of old growth forests does not reduce wildfire risk, and they are dissatisfied with the amount of public outreach available to American citizens. The following section examines what legislators at the state and local levels are doing to address harmful wildfires.

State and Local Wildfire Policy

In response to what they deem an inept, status quo approach from the Federal government, state legislatures have devised their own programs to educate the public and reduce wildfire hazards. In these states, citizens are educated about the complexities of wildfires and are encouraged to go beyond what is demanded by federal law to exercise additional precautions that reduce wildfire risk. While the National Fire Plan is responsible for wildfire fuel reduction across the nation, the federal departments and agencies are limited in what they can accomplish. Additionally, the National Fire Plan does not stress fuel reduction on private property. These circumstances have led California to pass the only laws in the nation that force the removal of biotic, fire-causing agents on private property. The laws establish what is known as defensible space.

California Public Resources Code Sections 4290 and 4291 define "defensible space" for wildfire protection areas of state and local responsibility (http://www.leginfo.ca.gov). These laws were passed into legislation in 1991. Defensible space in Section 4291 is defined as the area within the perimeter of a development, neighborhood, or community where basic wildland fire protection practices are implemented, providing the key point of defense from an approaching wildfire or escaping structure fire. Section 4291 sets the requirements for defensible space around trailers, homes, and businesses. Thus, 4291 is designed to maintain space around structures devoid of potential fire fuels.

In addition to Section 4291, Section 4290 sets various field requirements for on-site water storage, vegetation clearance, and road access. These laws are meant to guarantee road access for emergency vehicles and ample civilian evacuation routes. Dead-end roads must be kept to a minimum, and emergency vehicles must have access to roads sufficiently wide for turnarounds

while not posing any vertical clearance issues. Neighborhoods must be equipped with clear, legible street signs for quick conveyance of information. PRC 4290 also contains strict standards for new housing construction zones, requiring water supplies and hydrant systems to be fully sufficient for fire protection.

Depending on the size of their property, California homeowners must regulate their defensible space accordingly. Small patches of trees and shrubs should be surrounded by greenbelts, irrigated sections of grass or other noncombustible material such as rocks. Dead limbs, leaves, and ground litter must be routinely removed. Grasses and weeds are kept at low heights. Branches should be trimmed away from the roof and the rest of the home.

Fire Safe Councils

To get people to comply with these state laws, California has developed county-level public outreach programs called Fire Safe Councils which seek to demonstrate the importance of defensible space and greenbelts in wildfire protection. Local chapters are composed of sixty-one public and private organizations. These organizations are listed in Table 1.

Table 1. Members of the Fire Safe Council

Allstate Insurance	California Department of Insurance	Committee for Firesafe Dwellings	Pacific Gas and Electric
American Red Cross	Firefighters Association	Council for a Green Environment	Personal Insurance Federation
American Society of Landscape Architects	California Department of Parks and Recreation	Farmer's Insurance Group of Companies	Planning and Conservation League
Association of Contract Counties	California Fair Plan Association	Federal Emergency Management Agency	Roundup
Bureau of Land Management	California Farm Bureau Association	Fire Districts Association of California	Safeco Insurance
California Air Resources Board	California Fire Chiefs Association	Firewise	San Diego Gas and Electric
California Association of Nurserymen	California Forest Products Commission	Firemen's Fund Insurance	Society of American Foresters

(table continued)

California Association of Realtors	California Integrated Waste Management Board	Governor's Office of Emergency Services	South Coast Air Quality Management District
California Association of Resource Conservation Districts	California Landscape Contractors Association	Insurance Information Network of California	Southern California Edison
California Board of Forestry	California Sod Producers	Insurance Services Offices, Inc.	State Farm Insurance Companies
California Building Industry Association	California State Association of Counties	League of California Cities Fire Chiefs	Twentieth Century Insurance
California Cattlemen's Association	California State Automobile Association	Los Padres Forest Association	USAA Property and Casualty Insurance
California Department of Conservation	California State Fire Marshal's Office	The Nature Conservancy	USDA Forest Service
California State Association of Counties	California State Firefighters Association	National Audubon Society	
California Department of Fish and Game	California Urban Forests Council	National Fire Protection Association	
California Department of Forestry and Fire Protection	Chubb Insurance	Orange County Fire Authority	

(http://www.firesafecouncil.org/about)

Fire Safe Councils are diverse in achieving wildfire awareness. They sponsor awareness advertising campaigns, conduct workshops, publish brochures for homeowners, plot dangerous fire areas with Geographic Information Systems software, maintain web sites and services, and conduct fuel reduction activities in local forested areas. Generally, members from each of the council chapters meet monthly to discuss any fires of which they are aware, as well as news and current events. Interestingly, out of the fifty-eight counties in California, ten have no Fire Safe Council at all while other counties have several.

States lacking enforceable, state-level wildfire mitigation measures have also formed outreach programs meant to convince citizens to assist with their own hands. Montana, Idaho,

and Colorado have introduced land development codes and ordinances for subdivision design standards. Many of these programs are funded by the same kinds of local agencies in California. As in the case of California, some counties have several programs while others have none.

Research Questions

This research reviews the Fire Safe Councils of California. Since there is variation among the fifty-eight counties, it is important to examine what may account for these differences. Answers to the following research questions, designed to identify possible socioeconomic and wildfire hazard influences, should provide valuable insight into the conditions under which mitigation programs are more likely to take root.

- How does a county's population influence the decision to establish county-level programs for wildfire risk mitigation? Is population density key? How do population shifts in a county affect mitigation decisions? What if a significant portion of a county's population is below the poverty line?

- How does the economy of a county shape mitigation decisions? What is the relative influence of property taxes, per capita income, average value of housing, value of new construction, per capita county expenditures, and non-farm employment?

- What role does education play? Specifically, how does the percentage of a county's population with a college degree affect the decision-making process?

- Does rate of voting play a role? Are counties with high voting turnouts for general elections associated with county-level wildfire programs?

- How does the wildfire hazard rating affect whether or not a Fire Safe Council is present?

Review of Introductory Material

This chapter has presented an overview of the U.S. wildfire problem and has described the policy responses of the U.S. federal government and the California state and local governments. Also, research objectives of the thesis have been described. Chapter 2 presents research designed to assess these objectives.

CHAPTER 2

RELATED RESEARCH

Public Risk Perception

Slovik (1987), in his seminal paper, “Perception of Risk,” states that there are always controversies and confusions involved in risk perceptions. What social science and biological science tell us to perceive as health risks are often not seen as risky by the public. Scientists have a relatively simple model of risk, based on probability and severity of what may occur. The public takes many different variables into account, such as whether the proposed mitigation technique or activity is voluntary or non-voluntary. Usually, people tend to accept risk when it is voluntary. There are also questions of equity. Is the person who is exposed to the risk benefiting from the activity? The answer holds major implications as to how risk is perceived by the public.

Johnson (1993) notes in his article, “Advancing Understanding of Knowledge's Role in Lay Risk Perception,” that in many hazard cases, probabilities are not easily judged, and in these situations, the public can have equal knowledge with researchers or experts. Experts generally label personal concepts and generalizations as knowledge, making it difficult for the public to decide what is fact and what is opinion. In reality, there are several levels of both knowledge and ignorance, and it is often the method of communication that dictates how the public perceives risk. Thus, whoever is controlling communication has a great responsibility, because mere knowledge is not always valuable in a hazard situation. Meaning is not inherent in numbers and statistics, one must figure out what is meaningful for himself.

Shrader-Frechette (1990) maintains in her paper, “Perceived Risks versus Actual Risks: Managing Hazards Through Negotiation,” that all risk is perceived. Therefore, risk should not

be purely expert-based. What scientists refer to as "actual" risks are risk estimates which are dependent on being measurable by probabilities and consequences. Hazards often occur when non-quantifiable factors are present, such as nonconsensual risk, unknown risk, and risks posing threats to civil liberties. If risks threaten health, hazardous waste facilities for example, and are not compensable, society must decide whether they are avoidable. If the risks are unnecessary, society can forego the benefits gained through these hazards. If the risks are not avoidable, society must distribute the risk. This distribution should involve some form of compensation, since harm is certain.

Hazard Perception in the Media

Rodrigue (2001) maintains in her paper, "Construction of Hazard Perception and Activism on the Internet," that broadcast and print media have historically distorted risk perception dialogue between technical experts and policymakers. The author uses fires in Malibu to illustrate her point. 'Brady Westwater' set up a web page to accuse Mike Davis, who wrote a book about fires in California, of falsifying information about Malibu fires. Westwater claimed that fires in Malibu would decrease over time because of new fire resistant materials being used and increased access for fire trucks. In fact, Westwater was a realtor whose living depended on selling homes in the chaparral.

Dymon and Boscoe (1996) maintain in their paper, "Newspaper Reporting in Wake of the 1995 Spring Floods in Northern California," that the factors which make disasters memorable distort risk perception. The authors also assert that low risks are counted as no risk too often in U.S. reporting and that these errors lead to disasters. Following a study of national and local California papers reporting on the 1995 Spring Floods, the authors concluded that pictures and text do not satisfactorily communicate natural disaster information or natural hazard risk

information to the public. Instead, they assert that information should be in the form of maps, which they believe will give more factual information and will lead to a more geographically aware public.

Friedman (1994) noted in her article, "The Media, Risk Assessment and Numbers," that major network television programs often attempt to relate environmental risk in terms of numbers but do not explain to their audience what the numbers mean. This was evidenced in the February 26, 1989, airing of CBS's "60 Minutes." The program attempted to shed light on the danger of the Alar chemical used in the apple industry. At the time of the program, the National Resource Defense Council and the Environmental Protection Agency was still in major disagreement between Alar risk figures. CBS reported risk figures without knowing what they meant, thus had no way of knowing if Alar was a threat to the public. This is a perfect example of the media causing public outrage with no scientific basis.

Mazur (1994) suggests in his paper, "Technical Risk in the Mass Media," that specific media content does not drive the negative attitudes and reactions the public has toward hazards as much as total coverage does. This becomes important in hazard reporting because, according to Mazur, no matter how technical the reporting is, it must be transmitted beyond small press markets.

Rodrigue, Rovai, and Place (1997) state in their paper, "Construction of the Northridge Earthquake in Los Angeles' English and Spanish Print Media," that although earthquakes are unpredictable, research points to significant social differentiation in emergency relief, emergency recovery, and reconstruction across Los Angeles County. This differentiation, the authors cite, is due to media patterns throughout the city. Disaster management personnel conduct emergency recovery and reconstruction activities based on the damage maps available. These maps may be

strongly influenced by media coverage, with the possible result that wealthier communities may secure the majority of disaster aid. Poor communities and minority groups secure only a small amount of media coverage.

Risk Management Failures

In his paper, "Fire Safety Regulation in Northeastern Santiago, Chile," Cobin (2000) notes that the frequency of major fires per capita has dramatically increased in Santiago since major increases in building safety regulation. Fire safety regulation in Baltimore produced strikingly similar results. An explanation of this is that stricter building codes generate a false sense of confidence within the risk-perceiving public. Cobin maintains that public policy alternatives are often flawed because of uncertainties relating to public choice and knowledge. Building code policies are created before the sources of local wildfires are narrowly defined. During the time it takes to revise the policies, fires occur. The author suggests a shift in policy to more market-based private building and fire safety regulation. This would entail much less regulation of building codes. The savings involved would go to fire protection elsewhere.

Wildfire Effects on the Ecosystem

In their paper, "Effects of Fire Exclusion on Tallgrass Prairie and Gallery Forest Communities in Eastern Kansas," Abrams and Gibson (1991) explain how succession of multiple plant species found in gallery forests (thin bands of trees which line stream channels and ravines) and grassland ecosystems are affected when a source of wildfire is cut off. The prairie studied by the authors, the Konza Prairie of Kansas, showed that fire is a key regenerative component in ecosystems, especially when large numbers of herbivores are not present. When the United States's increasing population eliminated many large, wild herbivores while simultaneously adhering to the "no wildfire" policy, the stage was being set for the current

wildfire crisis. The reduction of fires allowed for gradual colonization of the grasslands by shade tolerant trees, ruining the ability of the prairie to sustain itself, while also reducing the net worth of the ecosystem by choking out high-energy-yielding trees such as oak trees.

Keeley (1991) states in his paper, "Fire Management for Maximum Biodiversity of California Chaparral," that there are basically two types of reproducing vegetation in the California chaparral, "fire recruiters," which germinate in and around wildfires, and "fire persisters," which do not need fire to reproduce. Keeley notes that much attention both within and outside of academic circles has been paid to the knowledge that the chaparral needs fire to survive. Indeed some species do. A management plan for long-term stability of the California chaparral should include biodiversity. Large wildfires are reducing biodiversity and the quality of the ecosystem in addition to causing human losses of life and property. Through his studies of different forests and ecosystems, Keeley maintains that for maximum health, forest management plans should be constructed which require sections of chaparral to be burned every twenty years. Over time, fire frequency regimes should fluctuate around this number. It is a small enough period for fire recruiters to renew themselves and is large enough for fire persisters to sustain themselves.

White, Waldrop, and Jones (1991) note in their paper, "Forty Years of Prescribed Burning on the Santee Fire Plots: Effects on Understory Vegetation," that, generally, as prescribed burning frequency increases to a certain point, grasses in the area tend to accumulate and grow taller. Relatively heavy burning also decreases the concentrations of woody vegetation and shrubbery. By setting up four distinct patches of land, each of which was burned at different intervals over an extended period, the authors asserted that winter burning ultimately reduces hardwood sprout vigor and can introduce disturbances into the ecosystem. These disturbances

can cause severe alterations in the area's vegetation over extended periods. The several vegetation types in the Santee Fire plots were all exposed to some degree of fire. The intensity, frequency, and the season in which the fire takes place determine how plant species adapt themselves. Differences in frequency and season of fire in the four patches of land produced four very diverse ecosystems, thus giving land managers a wide array of choices in managing their natural resources in a given area.

Economics of Wildfire Mitigation

In "Cost-Effective Wilderness Fire Management: A Case Study in Southern California," Childers and Piirto (1991) write that all of the Forest Service's management policies and strategies must be deemed cost-effective before they are implemented. Prescribed burns are often used to thwart dangerous, out-of-control wildfires, but they are not always cost-effective. In certain areas of Los Angeles County, it becomes very difficult to conduct burns, since the forests are surrounded by expensive private property. People continue to leave the noise and traffic of the city to build homes in and around the wildland/urban interface. The authors argue that a cost-benefit analysis should be used by the Forest Service to reflect the "real world" more accurately. The value of natural wildfires has been unquantifiable for a long time. We must consider them in terms of cost in dollars. We must therefore conduct costly prescribed burns with attention to how natural fires have occurred in the past, mimicking the natural fires as closely as possible. An example of this would be foregoing scheduled, multiple burnings in a chaparral area in Los Angeles County, which would be very costly if done safely considering all of the personnel and fuelbreaks that would be required. Instead, focus in Los Angeles should be on educating citizens about the perils of the wildland/urban interface and on enforcing California Public Resources Code Sections 4290 and 4291. Cost-benefit analyses should then be able to

assess whether containing the natural fires that spring up in an area over the long run is cheaper than prescribed burns. The authors conclude that decision trees are useful in conducting these analyses.

In her article, "Advocates See President Bush's Healthy Forest Initiative as a Way of Streamlining the Environmental Review Process," Reese (2003) explains that the program calls for improved procedures for fuel handling and forest restoration, reduction of environmental reviews, creation of a method to assess the risks and benefits associated with fuel handling and restoration, development of an environmental assessment model to ensure that fuel handling and restoration are consistent with NEPA, and restoration of fire-adapted ecosystems. Because it would enable foresters to bypass some of the environmental review processes established by NEPA, several elements of the initiative required Congressional approval. For example, the president lobbied Congress to approve legislation that would authorize agencies to enter into long-term "stewardship" contracts with private-sector organizations and communities. The National Association of State Foresters (NASF) supports the Healthy Forest Initiative, citing it as a way to put the National Wildfire Plan into action. This viewpoint is held in contempt by many environmental organizations, whose members assert that the initiative will severely undermine the goals which are set forth in NEPA. They argue that the economic benefits of increased logging in national forests will not add up to the environmental costs of pollution, habitat loss, and contributions to global warming.

Wildfires and Social Geography

According to Rodrigue (1993) in her paper, "Chaparral Fire Hazards and the Social Geographies of Risk and Vulnerability," the fire insurance industry and governmental planning agencies must be reformed to account for equity and the efficiency of fire-fighting resources

being compromised by hazards in which there is a strong voluntary component to risk exposure. As suburban hillsides become populated in fire prone areas where homeowners' associations are powerful and well funded, the state officials must use their public outreach networks and other tools to demonstrate how building in fire-prone areas takes fire fighting resources away from citizens in other areas.

In his article, "Evacuation Lessons Learned in the Rodeo-Chedeski Fires," Cook (2003) writes that while preparation and communication at all community levels are critical during times of drought, heavy fuel loads, and severe winds, often they are not enough. The Rodeo and Chedeski Fires burned over 468,000 acres of Arizona brush, destroyed over 500 structures, and forced 32,000 people from their homes in June and July of 2002. The author stresses that the majority of the area burned was in the wildland/urban interface. He adds that such dangerous weather conditions makes effective trimming around homes and usage of greenbelts very difficult. Another problem presented by fires over a large geographic area is that many people affected are vacationers and travelers. Since they do not live in the area, these people have little knowledge of natural hazards common to the area. Informing these people about fire conditions and evacuation routes before a state of fire emergency is reached is mandatory for preventing large-scale confusion and disaster.

Summary of Related Research

Chapter 2 contains research from various areas concerning the global wildfire problem which relates to the thesis objectives. The studies presented here were used as guides for creating the methodology which follows in Chapter 3.

CHAPTER 3

DATA AND METHODS

In an attempt to gain insight into factors of variation among California Counties in establishing Fire Safe Councils, several types of socioeconomic and hazard rating (risk) data were gathered for statistical testing. A total of twelve independent variables were considered according to certain requirements. Variables had to be "classic" indicators associated with policymaking decisions, and hard data had to be available for statistical analysis. Each variable is listed categorically in Table 2.

Data Description

All county data was collected from one of three sources: the California Institute for County Government; the U.S. Census Bureau; or the 1997 California Fire Safe Report. The California Institute for County Government keeps extremely detailed records which reflect population, economic, and environmental conditions of each California County, as well as trends within public finance, social services, public safety, and civic participation. Values for the following variables: per capita annual property taxes, % of population below poverty line, % voting public, value of new construction, and per capita county expenditures; were obtained from the CICG (www.cicg.org).

The U.S. Census Bureau provides population, property value, employment, and education data for each California County (http://quickfacts.census.gov). Census data was used to define the following variables: population density, % population change, per capita income, average value owner-occupied housing units, % population with college degree or higher, and number of private non-farm establishments with paid employees.

The 1997 California Fire Safe Report is a comprehensive wildland fire hazard assessment for the entire state of California. It contains a mitigation legislation list, as well as methods for fire hazard assessment and fire hazard zoning. Chapter Five of this report provides the LRA (Bates) Weather Rating Table, which generated the hazard rating variable for each of the fifty-eight California counties. A later report containing a hazard rating for each county was not found.

Table 2. Categories of Independent County Variables

Population	Economic	Education	Civic Participation	Wildfire Hazard
Population density	Per capita annual property taxes	% Population with bachelor's degree or higher	% Voting public	Hazard rating (1-3)
% Population change	Per capita income			
% Population below poverty line	Avg. value of owner- occupied housing units			
	Value of new construction			
	Per capita county expenditures			
	% Non-farm employment			

(compiled by Author)

At this point in the research, a regression analysis was not conducted, so there was no concern about whether the several variables within the economic category would impact each other or whether the lack of variables in other categories would impact the data analysis. The purpose of the study was to draw from as many socioeconomic and hazard-related areas as possible before defining the factors accounting for Fire Safe Council variation.

Data Coding

Population density: persons per square mile (2000)

% Population change: from April 1, 2000 to July 1, 2003

% Population below poverty line: (1999)

Per capita annual property taxes: (fiscal year 1999-2000)

Per capita income: (1999)

Average value of owner-occupied housing units: (2000)

Value of new construction: value of new building permits issued in unincorporated area per capita (2001)

Per capita county expenditures: (fiscal year 1999-2000)

Number of private non-farm establishments with paid employees: (2001)

% Population age 25+ with bachelor's degree or higher: (2000)

% Voting public: % of residents eligible to vote who voted in the 2002 general election

Hazard rating: hazard severity coded as 1, 1.5, 2, 2.5, and 3 with 3 being most severe (1997)

Defining Wildfire Hazards: The LRA (Bates) Weather Rating Table

While independent variables listed in the population, economic, education, and civic participation categories have values that are relatively easy to compile using census data, assigning a wildfire hazard rating to a county is a more selective process. The California Fire

Safe Report (California Department of Forestry and Fire Protection, 1997) contains published recommendations for fire hazard assessment under the Working Group Proposal. This proposal was made by a team of researchers who came together from various federal, state, and local agencies to analyze California and produce a system for assigning wildfire risk based on ranking dangerous fire-prone areas.

The Working Group used three primary sources for gathering the data needed to compose its rating system: Geographic Information Systems, local Ranger Unit Personnel, and local stakeholders. The Group proceeded through the following five topics which they believed would contribute to accurate hazard ratings for each county, after results from each were combined:

Wildfire fuel: vegetation types were assigned a fuel ranking 1, 2, or 3, 3 being most severe, to form an overall county fuel ranking

Elevation: an intensity rating of 1-9 was used to score six categories of elevations ranging from 0-3500 feet as a low mark and 8500+ feet as a high mark

Aspect: an intensity rating of 1-9 was used to score five categories of aspect degree

Slope: an intensity rating of 1-9 was used to score five categories of land slope degree ranging from 0-26 as low slope and 76+ as a high degree of slope

Severe weather frequency: an intensity rating of 1-9 was used to score county land areas in terms of susceptibility to severe weather using Remote Automated Weather Stations (RAWS)

(California Department of Forestry and Fire Protection, 1997)

A final “Severe Fire Weather” score for each county was obtained after averaging the ranked values for each of the five fire components and rescaling them 1, 2, or 3 (1 Moderate fie

hazard, 2 High, and 3 Very High). Some counties in the Bates Table are ranked Very High hazard with a High rating specifically for coastal areas while other counties are ranked High hazard with a Moderate rating specifically for coastal areas. For the purposes of this study and for simplicity in statistical testing, counties possessing two hazard scores were assigned the average of those two scores for their hazard rating.

Methods

The values of the twelve independent variables reflecting the socioeconomics and wildfire hazard ratings of the fifty-eight California counties were recorded into the statistical analysis software program, SPSS, along with a dependent variable reflecting whether each specific county contains at least one Fire Safe Council. The approach to data analysis was three-pronged, using the following tests made available by the software:

1) Difference of means comparison

2) ANOVA Oneway test

3) Pearson Correlation Matrix

The difference of means comparison identifies key influences on decisions on whether to form a Fire Safe Council for each county. For this test, the dependent variable is used to separate all counties into two sections: those containing at least one Fire Safe Council and those containing none. Next, the means are taken for each of the independent variables representing both sets of counties. Then, the means are compared to each other. Viewing the data in this way gives insight into how locations for Fire Safe Councils are chosen. By comparing the data for both sets of counties, similarities and differences between population, wealth, civic participation, education, and hazard rating appear.

The ANOVA Oneway test serves the function of a statistical significance test on the difference of means values, indicating the independent variables that significantly differ as both sets of counties are compared. Significant differences between mean values for a particular variable mean that the variable in question is somehow heavily related to Fire Safe Council formation. In essence, the variable is a factor accounting for variation in Council formation patterns.

The purpose of the Pearson Correlation Matrix is to explore the associations or lack thereof between the independent variables. Definite trends in demographic data exist that have been observed over time. For example, as education level in a region rises, per capita income usually does also. High average value of housing also corresponds to high per capita income. High population densities often signal high county expenditures. In addition to seeing how these indicators of education and wealth affect each other in California, assessing the impact of other variables, such as the wildfire hazard rating, % population change, and % voting public, allows observance of the complexities of wildfire hazard mitigation.

Review of Methodology

This chapter has laid out the steps that were taken to retrieve data which is pertinent to the research objectives. In-depth discussion on statistical testing of the data has been provided, and the results of these tests are presented in Chapter 4.

CHAPTER 4

FINDINGS

Results of data analysis are found in the following tables. Table 3 shows the results of the Difference of Means Comparison with statistical significance for the independent variables provided by the ANOVA Oneway test, and Table 4 contains the results of the Pearson Correlation Matrix.

Table 3. Difference of Means Comparison

Independent Variables	**Variable means for counties with at least one Fire Safe Council**	**Variable means for counties with no Fire Safe Council**
Population density	626.22 *	1,788.82 *
% Population change	4.61	4.95
Per capita annual property taxes	$182.78 *	$295.11 *
Per capita income	$20,892.26	$19,071.90
% Population below poverty line	14.50	16.75
Avg. value of owner-occupied housing units	$193,068	$158,820

(table continued)

% Voting public	40.78	40.30
% Population with bachelor's degree or higher	21.57	20.07
Hazard rating	2.64	2.70
Value of new construction	$1,689.14 *	$3,290.00 *
Per capita county expenditures	$1,283.73 ***	$2,097.50 ***
Number of private non-farm establishments with paid employees	13,907.02	5,688.30

* indicates significance at ≤ 0.1 (compiled by Author)

** indicates significance at ≤ 0.05

*** indicates significance at ≤ 0.01

Table 4. Pearson Correlation Matrix: Correlations that are significant at the 0.01 level (2-tailed)

Variable 1	Variable 2	Pearson R
Population density	Per capita annual property taxes	.455
Population density	Per capita income	.407
Population density	Avg. value of owner-occupied housing units	.401

(table continued)

Population density	% Population with bachelor's degree or higher	.449
Population density	Hazard rating	-.393
Population density	Per capita county expenditures	.508
% Population change	Avg. value of owner-occupied housing	-.409
% Population change	% Voting public	-.360
% Population change	% Population with bachelor's degree or higher	-.359
% Population change	Hazard rating	.457
Per capita annual property taxes	Per capita county expenditures	.911
Per capita annual property taxes	Number of private non-farm establishments with paid employees	.941
Per capita income	% Population below poverty line	-.779
Per capita income	Avg. value of owner-occupied housing	.921

(table continued)

Per capita income	% Population with bachelor's degree or higher	.925
Per capita income	Hazard rating	-.638
% Population below poverty line	Avg. value of owner-occupied housing units	-.698
% Population below poverty line	% Population with bachelor's degree or higher	-.648
% Population below poverty line	Hazard rating	.390
Avg. value of owner-occupied housing units	% Population with bachelor's degree or higher	.896
Avg. value of owner-occupied housing units	Hazard rating	-.671
% Voting public	Value of new construction	.408
% Population with bachelor's degree or higher	Hazard rating	-.623
Per capita county expenditures	Number of private non-farm establishments with paid employees	.871

(compiled by Author)

The existence of Fire Safe Council local chapters is significantly associated with four of the twelve independent variables observed in the study: population density, per capita annual property taxes, value of new construction, and per capita county expenditures. No significant associations were found between council formation and per capita income, % population change, % population below poverty line, average value of owner-occupied housing units, % voting public, % population with bachelor's degree or higher, hazard rating, or number of private non-farm establishments with paid employees. Only two of the five categories of independent variables outlined in Table 2 are significantly associated with council formation: population and economic factors. All variables concerned with education, civic participation, and wildfire hazard level were found as having no significant impact.

One may find it particularly odd that the wildfire hazard rating of a county was found to have no significant impact on Council formation. The Difference of Means Comparison in Table 3 shows that the hazard ratings for both sets of counties are virtually equal. Thus, whether a Council forms must hinge on other variables. For the particular fire hazard situation in California, these other variables correspond to low county population.

Effect of Population Density

Analysis begins at the first independent variable in the research, population density. The difference of mean values between the two sets of counties for the population density variable is described with a confidence interval of 0.071, meaning that there is a 7.1% or less chance that the observable difference does not really exist. The outcome of the population density analysis can be interpreted in a few ways. Throughout the state of California, population is nearly three times as dense in counties having no Fire Safe Council as compared to counties having at least one. This suggests that:

1) Statewide, people tend to inhabit low risk areas for wildfire.

2) Densely populated urban areas are removed from wildfire risk due to an absence of vegetation in the region.

3) The most wildfire prone areas in California are in extremely rural areas.

Fire Safe Councils being located in California's least dense counties can be explained because the focus of the National Fire Plan is on the wildland/urban interface. These wildland areas are sparsely populated compared to other parts of California. Rural areas usually contain the most sources of wildfire fuel, thus they are areas where public outreach programs are largely beneficial. In terms of locating public outreach centers on a state-level, the members of the Fire Safe Council are trying to move in the right direction.

Effect of Property Taxes

A statistical difference between the per capita property tax means of both sets of counties exists. Overall, counties that have a Council have much lower property taxes. This is indicative of a lower population for these counties, since urban property is generally worth more than rural property. The concept of scarcity applies to property taxes; space is most valuable where it is least available.

Analysis of the population density and per capita property taxes variables clearly shows that the locations of Fire Safe Councils are heavily related to low county population. When population density data and property tax data is compared with data from other variables, this assertion is further supported.

Effect of Value of New Construction

There is a significant difference in the mean values for the value of new construction

between the two sets of counties. Analysis indicates that less new construction is taking place in counties with a Council. Again, this is indicative of a lower population in these counties. Densely populated areas tend to develop at faster rates than adjacent rural areas due to the high demands for space surrounding urban areas.

Effect of Per Capita County Expenditures

A statistical difference between the per capita county expenditures means of both sets of counties exists. Fire Safe Councils tend to be located in counties where overall spending is lowest. These counties are also sparsely populated. Analysis of per capita county expenditures, the fourth variable found to significantly associate with formation of a Council and also indicate low county populations, strengthens the assertion that Council locations are related to low county populations more than any other single factor or combination of factors.

Pearson Correlation Matrix

The Pearson Correlation Matrix revealed several associations between variables that have been observed over time in similar studies. This is seen as a positive, i.e., there is only a small chance of there being large errors in the data, the data collection for this particular study, or the analysis. Some of the positive relationships observed, where one variable increases as another increases, are: per capita property taxes to per capita county expenditures; per capita income to average value of owner-occupied housing; per capita income to % population with bachelor's degree or higher; and average value of owner-occupied housing to % population with bachelor's degree or higher. Some of the negative relationships observed, in which one variable decreases as another increases, are: % population below poverty line to % population with bachelor's degree or higher; per capita income to % population below poverty line; and % population below poverty line to average value of owner-occupied housing.

There is a group of correlations which demonstrate how wildfires remain a problem in California despite the myriad of mitigation attempts made at state and local levels. One of these key correlations is the positive one between % population change and hazard rating. The majority of people who change residency in California are moving into riskier, more fire-prone areas. They are moving into the wildland/urban interface.

People tend to accept risk when it is voluntary (Slovik, 1987), so a risk manager may surmise that the majority of people moving into riskier areas are wealthy people who are choosing seclusion from the bustle of city life over safety from wildfires. In this scenario, a need for space and tranquility inspires homeowners to relocate to the wildland/urban interface. Risk management specialists have often tried to show how important it is to keep fire-prone areas (where there is a strong voluntary component to risk exposure) from compromising the fire-fighting resources of other areas (Rodrigue, 1993).

The negative relationship between % population change and average value of owner-occupied housing, the positive relationship between % of population below poverty line and hazard rating, and the negative relationship between per capita income and hazard rating dispel the popular myth that the wildlife/urban interface is being populated mainly by wealthy residents. The interface is being expanded mostly by people who have little choice in accepting the risk. Putting this into context with where Fire Safe Councils tend to be found brings a sense of clarity to California's wildfire problem. Councils are found mainly in counties with low populations, but eventually, development in more populated counties continues until homeowners have little choice but to live in much riskier zones. The safety provided by fire-retardant surfaces such as concrete and asphalt shrinks as areas devoid of plentiful vegetation grow outward and come into contact with wildlands.

Summary of Findings

This chapter indicates the factors which significantly associate with formation of a Fire Safe Council, providing a scenario of where Councils are likely to be found. Relationships between significant factors were explored, as well as relationships between other variables which pointed to problems associated with the locations of Councils. These preliminary findings shed light on the conditions under which wildfire mitigation programs are adopted. The fifth and final chapter offers conclusions and policy recommendations based on these findings.

CHAPTER 5

CONCLUSIONS AND POLICY RECOMMENDATIONS

In summary, only four of the twelve independent variables in the study of California were observed to be significantly associated with a county's decision to form a Fire Safe Council local chapter or not. Significant associations were found only for population density, per capita annual property taxes, value of new construction, and per capita county expenditures. These variables represent two of the five categories of independent variables, population and economic status, indicating that civic participation, education, and hazard rating have no detectable association or influence on Fire Safe Council locations.

Public Resources Code Sections 4290 and 4291

This study provides perspectives from which to assess wildfire policy in California, especially Public Resources Code Sections 4290 and 4291. Analysis of each of the twelve independent variables shows that the statewide wildfire hazard problems far surpass any positives that can be brought about by enforcing defensible space around the home. The protection offered by a strict following of 4290 and 4291 is not absolute. As large fires merge and come into contact with optimal weather conditions, no degree of greenbelts and tree trimming will thwart the advances (Cook, 2003). The relationships among several variables included in the Pearson Correlation Matrix show that people are moving into riskier areas, and in most cases, the people who are moving are not wealthy. These people may not have access to public outreach, thus may not be educated on wildfires, and/or they may not have the resources to take the required precautions with their home.

There is a definite need for defensible space requirements. There must be a baseline of

security, a minimum of physical deterrents, employed by the property owner against the wildfire threat. However, there must be additional mandated policies.

Developmental Carrying Capacity

One possible wildfire policy that should be considered in California is a form of zoning which is closely tied to the most accurate wildfire hazard models available to decision-makers. This program would attempt to determine the developmental "carrying capacity" for regions within the wildland/urban interface. A question this zoning approach would seek to answer is: "How far out can we build in the wildland/urban interface before we significantly increase wildfire risk?" Defining "significant," however, causes numerous problems. A program that limits development in this way would dampen economic growth in California, and would be met harshly by many concerned citizens. Limiting community growth limits construction of businesses, roads, and homes. Jobs associated with these areas are highly needed in many communities. However, this research suggests that a bold shift in policy is necessary to restrict the extent of interface encroachment. If attention were paid to hazard models prior to construction in the wildland/urban interface, the likelihood of wildfire disasters could be reduced. Some of the more dangerous areas would not be inhabited. In order to compensate for areas in which construction is not allowed, communities would be forced to implement the principles of "smart growth," which help prevent urban sprawl. Smart growth is a maximization of green, open spaces in a community via efficient uses of resources, building designs (such as taller buildings covering less ground area), and existing infrastructures (www.smartgrowth.org).

Placing Value on Hazard Analyses

The rationale for conducting large-scale hazard analyses is to produce results for regions

(some form of hazard rating, perhaps), which serve as guides for making environmental policy decisions. The results of this research indicate that hazard analyses are less important than population and/or economic factors as potential influences on decision-makers' choices for Fire Safe Council locations. This brings up the question of whether hazard analyses are generally less important to decision-makers than population and/or economic factors. Since the mean hazard ratings for counties with Fire Safe Councils are similar to the means for counties lacking a Council, it is necessary that another hazard analysis be conducted which is more precise and accurate than the LRA (Bates) Weather Rating Table. The FARSITE model, for example, which has more hazard level outputs (very low, low, moderate, high, very high risk, etc.) than the Bates model, could be used to construct the county hazard ratings to see if a different hazard model would produce different mean hazard ratings for each set of counties. Unfortunately, the Working Group used the Bates Model exclusively in assigning each county a hazard level.

Directions for Future Research

There is much need for several kinds of environmental studies to be done across the country, similar to the study explained herein, to see whether most hazard analyses affect policy decisions. Much effort, manpower, and time is expended across the United States, especially in our universities, to create the software and models used in our natural hazard analyses. Much of the resources used in preparation of these models are subsidized by the American taxpayer. Society needs to know the extent to which these models impact their lives and the extent they reduce the risk of environmental hazards.

Several Western U.S. states have wildfire programs: Colorado, Idaho, Montana, and others. A valuable large-scale project would be to conduct fire hazard ratings for these states (most states beside California lack a rating system because they do not have state-enforced

mitigation laws). Using a multivariate analysis, the ratings could then be compared to socioeconomic variables such as those used in this study to determine whether they have any significant impact on the adoption of wildfire mitigation programs. For example, is the negligible policy impact of wildfire hazard ratings confined to California, or is it a much more common phenomenon? Similar case studies on the many U.S. environmental hazards and the mitigation programs used to address them are topics that should be researched by scientists and graduate students.

Summary

This study has attempted to further our understanding of the conditions under which county officials and citizens adopt wildfire risk mitigation programs. Such insight is beneficial not only to wildfire mitigation, but also to a variety of public policies aimed at reducing natural hazards and protecting natural resources. It will become increasingly important to design effective environmental policies which motivate private citizens to make positive and meaningful changes in their behavior.

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